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NASA TECH BRIEF

Lewis Research Center

A Superior Process for Forming Titanium Hydrogen Isotopic Films

A unique process has been developed for forming stoichiometric, continuous, strongly bonded titanium hydrogen isotopic films. The films have thermal and electrical conductivities approximately the same as bulk pure titanium, ten times greater than those of usual thin films.

Continuous thin films of stoichiometric titanium dihydride, dideuteride, or ditritide can be formed by this process. Films made with deuterium or tritium are useful as superior neutron generator targets, corrosion resistant coatings, hydrogen diffusion barriers, or for storing hydrogen. Previously, TiH_2 and TiD_2 compounds have been formed but only as powder. Titanium films partly loaded with deuterium or tritium are in general use as neutron generator targets, however, such films approximate TiD_1 or TiT_1 and consist of a two-phase mixture of titanium metal and titanium deuteride or tritide. Previously made films are porous and brittle, have poor electrical and thermal conductivity, and flake into powder at near stoichiometric conditions.

This film forming process is carried out in a modified commercial ultrahigh vacuum system capable of approximately 10^{-11} torr vacuum. The substrates are chemically cleaned and then placed in the vacuum system for final surface preparation by sputter etching in a low pressure argon atmosphere. The argon is pumped out and a titanium sublimator first coats the shroud surrounding the substrate holder with a thin film of titanium to getter contaminant gas molecules, and then deposits titanium on the substrates until the desired film thickness is achieved. A commercial quartz crystal thickness monitor is used to measure film thickness in situ. After the titanium film is formed, the hydrogen isotope gas is bled into the vacuum chamber where it is absorbed by the titanium.

Titanium deuteride films approximately three micrometers thick have been made by this process which had a chemical composition of $TiD_{1.96}$. The titanium films were deposited in 16 to 18 hours with the sublimator running at an 0.5 grams/hour rate. Approximately 100 hours were required to form the titanium dideuteride film in a deuterium atmosphere of 10^{-5} torr and with the substrates at a temperature of 282 K (48°F). Films were formed on platinum, glass and copper substrates. Stoichiometric films can also be formed at higher pressures or higher substrate temperatures in correspondingly shorter times provided that the rate of gas diffusion into the titanium film is greater than the rate of adsorption at the surface.

Notes:

1. This process can also be utilized for hydride, deuteride or tritide formation of other materials that absorb and diffuse hydrogen readily, e.g., zirconium and erbium.
2. Requests for further information may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B75-10001

Patent Status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

NASA Patent Counsel
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